JPEG 2000 Implementation Guide

James Kasner

NSES – Kodak

james.kasner@kodak.com

+1 703 383 0383 x225

Why Have an Implementation Guide?

- With all of the details in the JPEG 2000 standard (ISO/IEC 15444-1), it is still incomplete.

- Why?
  – The standard describes a *decoder*

  – It makes non-normative remarks regarding encoders

  – Implementer is left to fill in the blanks

  – Standards are notoriously short on examples

  – Things are not always as clear as we would like

- Implementation Guide was created to address these issues
  – Find it at: http://164.214.2.51/protected/ntb/J2K_Guide_WD1.pdf

    • This is the protected area of the NTB website

    • For access look at http://164.214.2.51/ntb/baseline/toc.html

  – Even though it's a working draft, it's a very good document

Areas Where the Guide Helps

- Further/alternate explanation of the JPEG 2000 standard
  - Packets headers and tag trees

- Examples to illustrate various processes in JPEG 2000

- Things you need to know to make an encoder
  - Rate and distortion estimation procedures for rate control
  - Layer formation
  - Computation of 9-7I wavelet subband energy weights
  - Design of quantization factors for 9-7I wavelet
  - Application of human visual weights to quantization

- In the future we plan to include coding improvements for specific data types

Guide Highlights

- ## Sections 2.1 and 2.2

  - Give overview of the JPEG 2000 processing flow

  - Introduction to JPEG 2000 nomenclature and constructs

    - Tiles, Reference grid, Resolution and decomposition levels

    - Code blocks, Precincts, Packets, Layers and coding passes

- ## Section 2.3

  - Describes major processing sections in JPEG 2000

  - High level image and tile processing procedures

  - Reference grid equations and interrelationship between

    - Image and tile size/offsets

    - Resolution levels and wavelet subbands

    - Component subsampling

    - Computing the size of a tile-component

    - Computing the number of pixels/coefficients

Guide Highlights

- ## Section 2.3 (continued)

  - ### Wavelet transform processing

    - #### Mechanics of lifting with examples
      - Signal flow graphs
      - Interleave and de-interleave procedures

    - #### Determining convolution equivalent wavelet synthesis filters (9-7I)
      - Used in design of quantization factors for 9-7I wavelet

    - #### Small tiles with vanishing dimension in wavelet decompositions
      - Leads to empty or one dimensional subbands

  - ### Quantization

    - #### Explicit quantization of 9-7I wavelet coefficients
      - Forward and inverse quantization procedures
      - Inverse quantization when all bitplanes have not been received

    - #### Implicit quantization of 5-3R wavelet coefficients
      - Forward and inverse quantization procedures
      - Inverse quantization when all bitplanes have not been received

Guide Highlights

- Section 2.3 (continued)
  - Quantization (continued)
    - "Base step size" quantization for 9-7I wavelet
      - Design technique that takes single quantization step and tailors it individually for each wavelet subband
      - Computation of energy weights
        - Needed for base step size design
        - Based on convolution equivalent wavelet synthesis filters
        - Determination of energy weights in the presence of small tiles (update coming for section)
      - Modification of procedure when using HVS weights
  - Arithmetic entropy coder
    - Various coding passes
    - Derivation of contexts
    - Different modes

Guide Highlights

- Section 2.3 (continued)
  - Rate-distortion estimation
    - Necessary for proper layering
    - Rate estimation
      - More accurate method to compute number of bytes out of arithmetic coder when truncating at the end of a coding pass
    - Distortion estimation
    - Binary search layer formation algorithm
  - Better explanation of packet headers and tag trees
    - Pseudo code and examples

Summary

- Implementation guide is a companion to the standard
  - Tried to make the more difficult sections easier to understand
  - Best to have both on hand
  - Will continue to update the guide

- If you need further help
  - Taubman&Marcellin, JPEG2000: Image Compression Fundamentals, Standards and Practice, KAP, 2001. ISBN 0-7923-7519-X